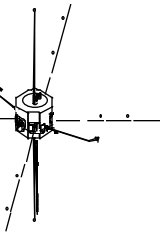
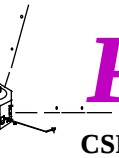


CSLP Technical Discussion

Space Environment
Day 1

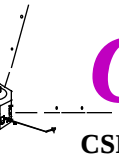
Cooperative Satellite Learning Project
(CSLP)



Purpose

CSLP Technical Discussion Series, Cooperative Satellite Learning Project

To explain what a vacuum is and discuss the temperature in space.



Outline

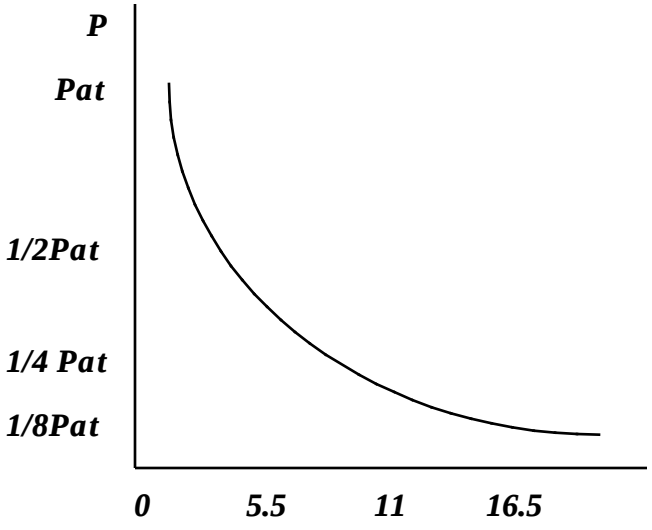
- **Understanding a Vacuum**
- **Temperature in Space**

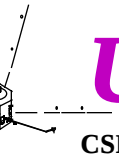
Understanding a Vacuum

CSLP Technical Discussion Series, Cooperative Satellite Learning Project

- **The density and pressure of our atmosphere is not constant. The pressure and density of our atmosphere decreases with height as you go up from the surface of the earth. That is why at very high altitudes cabins of jet planes must be pressurized.**

Variation in pressure with height above the earth's surface. For each increase in height of 5.5 km, the pressure decreases by half.





Understanding a Vacuum cont'd

- **The absence of all substances is a vacuum.**
- **The force per unit area is called pressure**
  - ***P* = *F/A***
  - ***F* = Force and *A* = Shear Stress**

Temperature in Space

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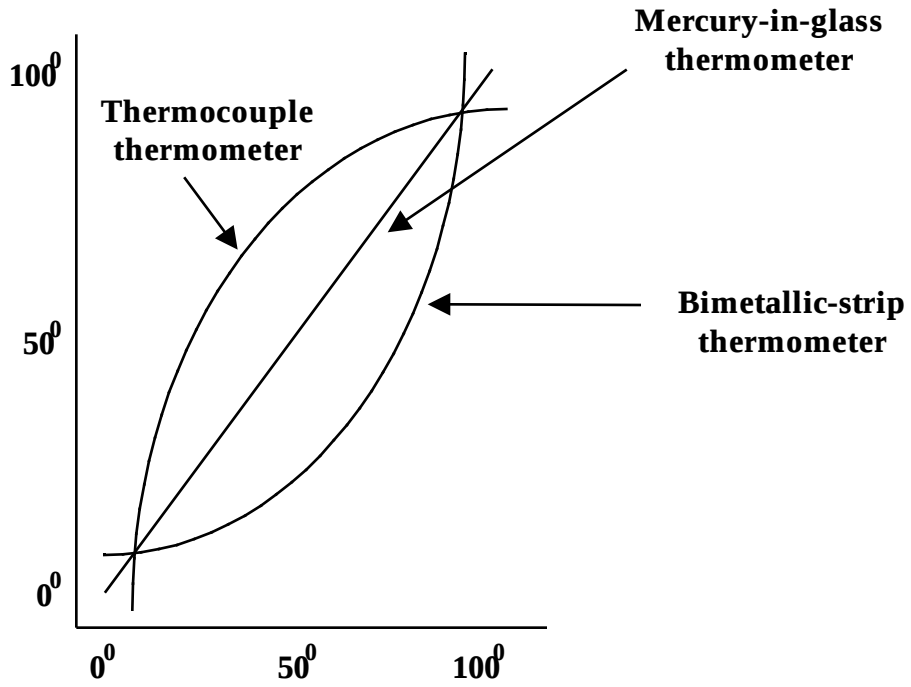
Temperature Scales

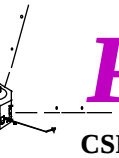
- Celsius
- Fahrenheit
- Kelvin



A schematic representation of the comparative readings of different natural thermometers. The differences are exaggerated.

Temperature in Space cont'd

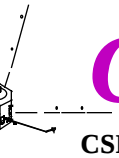
- **Absolute Zero**
  - **When substances are cooled, their molecules slow down. At an extremely low temperature of approximately -273 degrees Celcius (-460 degrees Fahrenheit) the molecules almost stop moving completely, and they have virtually no heat energy. It is impossible to make anything colder than this, so this temperature is called Absolute Zero.**
- **The temperature of the atmosphere decreases steadily with altitude.**



Purpose

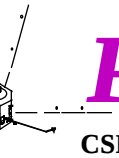
CSLP Technical Discussion Series, Cooperative Satellite Learning Project

To introduce to students the nature of planets



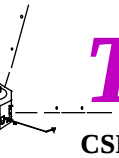
Outline

- **Planetesimals**
- **Types of Planets**
  - **Solid**
  - **Gaseous**
- **Recent Missions to Various Planets and the Conditions Faced**



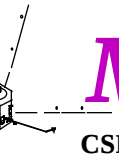
Planetesimals

- **Planetesimals are gas and dust particles, which were clumped together. The clumps became tiny planetlike bodies of iron, nickel, rock and ice. There are about a trillion planetesimals swarmed around the protosun.**



Types of Planets

- **There are two types of planets: solid and gaseous.**
  - **The solid-type planets, Earth, Venus, Mercury, and Mars are mostly solid matter and were formed by planetesimals that collided.**
  - **The gas-type planets, Jupiter, Saturn, Uranus, and Neptune were formed primarily of leftover gases.**



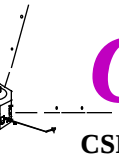
Missions

- **Mariner 10 visited Mercury and discovered the airless planet has no erosion, no volcanoes and no recycling of its rocks.**
- **The Pioneer Venus Orbiter revealed about Venus the layers of sulphuric acid cloud, a hot volcanic surface.**
- **Voyager 1 probed Jupiter. It is made almost entirely of gases, at its weather patterns appear as ovals that are white or orange in colour.**

Purpose

CSLP Technical Discussion Series, Cooperative Satellite Learning Project

To introduce the students to the fields



Outline

- **Magnetic Fields**
  - **The Earth's Magnetic Field**
  - **What is a vector?**
  - **Concept of a vector field**
- **Gravitational Fields**
  - **Acceleration of Gravity**

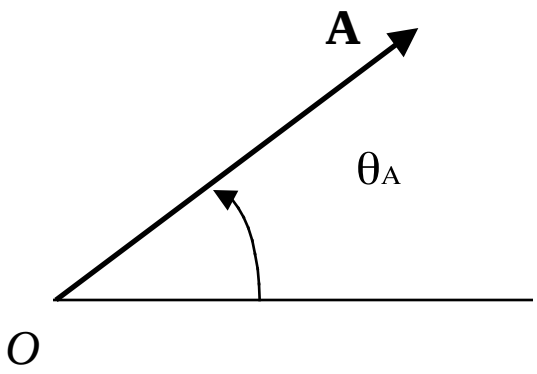
Magnetic Fields

The Earth's Magnetic Field

- The earth's magnetic field can trap charge particles that come in from outer space. These particles then spiral back and forth from magnetic pole to magnetic pole. In this way the magnetic field protects us from these charged particles. When these particles get close to the earth's surface, aurorae are produced.

Vector

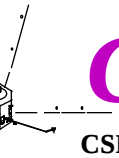
- Quantities with magnitude and direction that add and subtract like displacements.



Specifications of Vector A

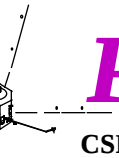
Magnetic Fields cont'd

- **Concept of a Vector Field**
  - **The attraction of the earth by the sun in two steps. The sun creates a condition in space that we call the gravitational field. This field produces a force on the earth. The field is thus the intermediary agent.**



Gravitational Fields

- **Acceleration of Gravity**
  - **In the absence of air resistance all objects near the surface of the earth fall with the same acceleration. This quantity is called the acceleration of gravity (g). The actual value of g on the earth's surface is 9.8m/s/s.**
- **Gravitational field of the earth**
  - **$g(r) = F/m = GM_E/r^2$**



Purpose

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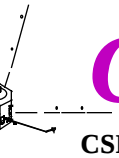
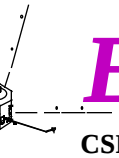
To introduce to students orbital physics



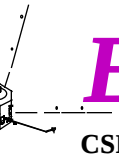
Outline

- **How gravity affects the physics of launch vehicles**
- **Escape velocity**
- **Centripetal force/acceleration**
- **Orbits**



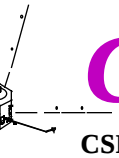
Effects of Gravity

- **There is no acceleration without a force. In order for a spacecraft to achieve orbit it must overcome the gravitation force. This is done by taking advantage of Newton's second law: every force is accompanied by an equal and opposite force.**



Escape Velocity

- **The minimum launch velocity that allows us to put something into orbit is called the escape velocity. The escape velocity for an object is found by considering the conservation of energy. The earth's escape velocity is about 11km/s; this is the speed that a spacecraft launched from earth must reach.**

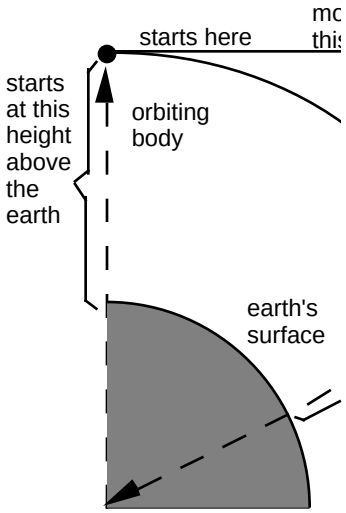


Centripetal Force

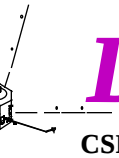
- **Centripetal force is the inward force necessary to maintain uniform circular motion. From Newton's second law of motion, the magnitude of the centripetal force must equal to the product of mass and centripetal acceleration. The centripetal acceleration represents only a change in the direction of motion.**

Orbits

- **There is a speed at which the curved path of the projectile exactly follows the curvature of the earth's surface. Thus the projectile never reaches the surface of the earth even though it is constantly falling. It always stays the same height above the surface. In this case, we say the projectile is in orbit.**



An orbiting body is really falling around the earth, but the earth curves away at the same rate that the body falls



Discussion Questions

- **What is gravitation force?**
- **What is centripetal acceleration?**

Purpose

To inform the students about the electromagnetic spectrum and radiation.

Outline

- **Electromagnetic Spectrum**
  - **The Spectrum**
  - **Electromagnetic Waves**
  - **Frequency**
  - **Wavelength**
  - **The Spectrum How the Atmosphere affects the spectrum?**
- **Radiation**
  - **The Sun**
  - **Van Allen Belts**
  - **Cosmic Rays**

The Electromagnetic Spectrum

- **The spectrum**
  - **The range of various types of electromagnetic radiation, divided into the radio, infrared, visible, ultraviolet, x-ray, and gamma-ray sections.**
- **Electromagnetic Waves**
  - **If an oscillating current (one that changes direction rapidly, flowing first one way, then the other) were set up an electromagnetic wave would result.**

The Spectrum cont'd

- **Frequency**
  - **The number of waves passing a given point in a second. When wavelenth decreases, frequency increases. The greater the frequency the greater the energy.**
  - $f = 1/T$
- **Wavelength**
  - **The distance between (length of one wave) peaks of one cycle of electromagnetic radiation. The shorter the wavelength of the light, the greater the energy.**
  - $v = \lambda/T = f\ \lambda$

The Spectrum cont'd

- **How the Atmosphere affects the Spectrum?**
  - **Only about 300-400 nanometers of ultraviolet radiation reaches the earth because the rest is filtered out by the upper layers of the atmosphere.**
  - **The atmosphere prevents the passage of X radiation because atoms and molecules in the air disperse the energy.**

The Spectrum cont'd

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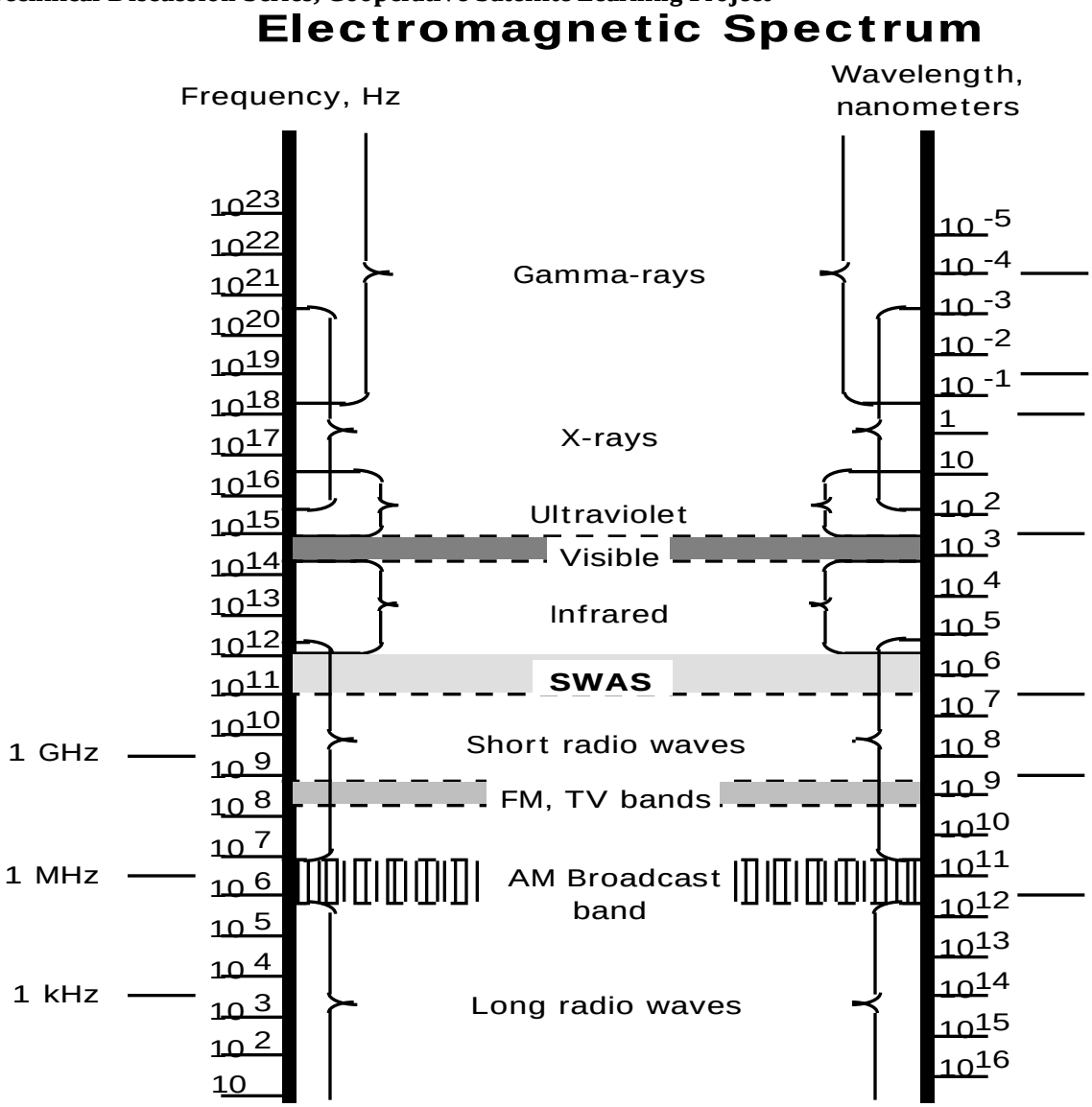

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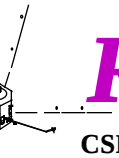
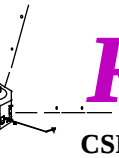


Radiation

- **The Sun**
  - **Ultraviolet rays**
  - **Subatomic particles**
    - **They affect the nebulous gases that compose a comet.**
  - **Radio waves**
    - **Communication**
- **Van Allen Belts**
  - **The variety of radio temperatures could be caused by high-speed electrons accelerated in a powerful magnetic field. Earth is surrounded by such electrons trapped in doughnut-shaped belts, the Van Allen Belts.**
- **Cosmic rays**
  - **Pilots are most exposed. No known harms.**



References

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- **Physics by Nigel Henbest & Heather Couper. Copyright 1983.**
- **The Planets by Nigel Henbest. Copyright 1992.**
- **Space and Planets. Time Life**
- **Invitation to Physics by Jay M. Pasachoff & Marc L. Kutner. Copyright 1981.**
- **Applied Physics by Dr. Jack Tippens. Copyright 1985.**
- **The Electromagnetic Spectrum by Franklyn M. Branley. Copyright 1979.**